Enumeration Studies of Coho Salmon at Black Creek: 1995 Adults and 1996 Juveniles and Adults

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ABSTRACT

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A new fish counting weir was constructed on Black Creek in the summer of 1995 for the purpose of continuing the coho salmon (*Oncorhynchus kisutch*) enumeration studies that began in 1985. Black Creek flows into the Strait of Georgia between Courtenay and Campbell River.

We counted 759 adult (age .1) males, 831 females and 1150 jacks (age .0 males) between 11 October and 20 November 1995. Adipose fin clips, indicating the presence of a coded-wire tag, were observed on 83.8%, 84.8% and 93.7% of the males, females and jacks, respectively. A portion of a dyke was washed away near the end of the run, allowing some adults to bypass the weir. Counted coho had been tagged at the weir and recoveries were made upstream, allowing us to estimate a total run of 1760 adults (850 males and 910 females). Average POH (post-orbital to hypural) length, FL (fork length) and weight were: males POH 478 mm, FL 616 mm, weight 2.95 kg; females POH 522 mm, FL 634 mm, and weight 3.50 kg; and jacks POH 278 mm. 98.5% of the adults were age 1.1 and 84.1% of the jacks were age 1.0. Marine survival was 4.5% and exploitation rate was 56.5%.

The weir was operated again from 27 April to 13 June 1996 when 14,178 coho smolts were enumerated. Of these, 13,828 were injected with a coded-wire tag and adipose clipped. Almost all (99.3 %) were age 1.0. The average fork length of age 1.0 and 2.0 smolts was 131 mm and 152 mm. Twenty-four hour tag retention was estimated to be 99.3%.

The final period was 18 October to 30 November 1996. Only 82 males, 65 females and 329 jacks were seen, the lowest run since counts began. Adipose clips were noted on 62.2%, 66.2%, and 16.1% of the males, females and jacks, respectively. The estimated escapement was 284 adults (126 females and 158 males) and 678 jacks. Average sizes were: males POH 424 mm, FL 541 mm, weight 2.00 kg; females POH 504 mm, FL 620 mm, weight 3.00 kg; and jacks POH 265 mm, FL 332 mm, weight 0.50 kg. A regression was calculated for the relationship between POH and fork length. 89.7% of the adults were age 1.1 and 95% of the jacks were age 1.0. Marine survival was 3.4% and exploitation rate was 70.2%.

RESUME

Baillie, S. J., Simpson, K., and Taylor, J. A. 2004. Enumeration studies of coho salmon at Black Creek: 1995 adults and 1996 juveniles and adults. Can. Manuscr. Rep. Fish. Aquat. Sci. 2698: vi + 49 p.

Une nouvelle barrière de dénombrement du poisson a été construite dans le ruisseau Black à l'été 1995 afin de pouvoir poursuivre les études de dénombrement du saumon coho (*Oncorhynchus kisutch*) lancées en 1985. Ce ruisseau se déverse dans le détroit de Georgia entre Courtenay et Campbell River.

Nous avons dénombré 759 mâles adultes (âge 1), 831 femelles et 1 150 madeleineaux (mâles d'âge 0) entre le 11 octobre et le 20 novembre 1995. L'absence d'une nageoire adipeuse, qui indique la présence d'une micromarque magnétisée, a été observée chez 83,8 %, 84,8 % et 93,7 % des mâles, des femelles et des madeleineaux, respectivement. Une partie d'une digue a été emportée par les eaux vers la fin de la remonte, de sorte qu'un certain nombre d'adultes ont passé à côté du barrage. Nous avons étiqueté les cohos dénombrés au barrage et les avons récupérés en amont, ce qui nous a permis d'estimer la remonte totale à 1 760 adultes (850 mâles et 910 femelles). La longueur du post-orbitaire aux hypuraux, la longueur à la fourche et le poids moyens respectifs étaient les suivants : 478 mm, 616 mm et 2,95 kg chez les mâles et 522 mm, 634 mm et 3,5 kg chez les femelles. Chez les madeleineaux, la longueur du post-orbitaire aux hypuraux s'élevait à 278 mm. Des adultes, 98,5 % étaient d'âge 1,1 et des madeleineaux, 84,1 % étaient d'âge 1,0. Le taux de survie en mer se chiffrait à 4,5 % et le taux d'exploitation à 56,5 %.

Nous avons utilisé le barrage à nouveau du 27 avril au 13 juin 1996 et y avons dénombré 14 178 smolts de coho. Nous avons injecté une micromarque magnétisée à 13 828 de ceux-ci et leur avons aussi rogné la nageoire adipeuse. Presque tous (99,3 %) étaient d'âge 1. La longueur moyenne à la fourche des smolts d'âge 1 et d'âge 2 s'élevait respectivement à 131 mm et 152 mm. D'après nos estimations, 99,3 % des smolts ont retenu la micromarque pendant au moins 24 heures.

Nous avons fait un dernier dénombrement du 18 octobre au 30 novembre 1996. Nous n'avons vu que 82 mâles, 65 femelles et 329 madeleineaux, soit la plus faible remonte depuis le début des dénombrements. La nageoire adipeuse avait été rognée chez 62,2 %, 66,2 % et 16,1 % des mâles, des femelles et des madeleineaux, respectivement. D'après nos estimations, l'échappée se chiffrait à 284 adultes (126 femelles et 158 mâles) et 678 madeleineaux. La longueur du post-orbitaire aux hypuraux, la longueur à la fourche et le poids moyens respectifs étaient les suivants : 424 mm, 541 mm et 2,0 kg chez les mâles; 504 mm, 620 mm et 3,0 kg chez les femelles; et 265 mm, 332 mm et 0,5 kg chez les madeleineaux. Une analyse de régression de la relation entre la longueur du post-orbitaire aux hypuraux et la longueur à la fourche nous a permis d'établir que 89,7 % des adultes étaient d'âge 1,1 et 95 % des madeleineaux d'âge 1. Le taux de survie en mer s'élevait à 3,4 % et le taux d'exploitation à 70,2 %.

INTRODUCTION

The Black Creek Coho Project is an annual monitoring of smolt abundance and spawner escapements which entails enumerations, sampling of biological characteristics and coded wire tagging and tag recovery. One of only three wild stock assessment projects on the south coast of British Columbia, its results are extrapolated to other wild coho stocks in the Strait of Georgia and are used in the management of coho catches and assessment of freshwater habitat impacts. Specifically, coho smolts are enumerated, sampled and coded wire tagged as they leave Black Creek in the spring and 'jacks' and 'adults' (age X.0 males and age X.1 adults).

This manuscript report presents enumeration and sampling data from Black Creek, Vancouver Island, during the fall adult coho *(Oncorhynchus kisutch)* season in 1995, the spring 1996 coho smolt season and the fall 1996 adult coho season.

The Black Creek Project is an annual stock assessment activity with two field objectives:

1. To estimate the number of coho smolts and sample some of their biological characteristics. Smolts are tagged with coded wire tags (CWT) to identify them in catches and escapement.
2. To count or estimate the escapement of coho to Black Creek and ascertain some biological characteristics of the return (e.g. size, sex and age).

Recoveries of coded wire tagged coho in the escapement are used with release data and catch recoveries to estimate ocean survival and exploitation rates. Long-term monitoring of escapements, smolt abundance, survivals, catches, exploitations and escapements of Black Creek coho are used by Fisheries and Oceans Canada as an important tool for managing Strait of Georgia coho. Data from the project, along with other sources, is used to predict coho returns, ocean survival and migration patterns for the south coast of British Columbia.

Black Creek is located on the east coast of Vancouver Island, British Columbia, Canada. The system discharges into the Strait of Georgia at 49° 51' N and 125° 06' E, approximately 23 km south of the city of Campbell River and 20 km north of the city of Courtenay (See Figure 1.1). The counting weir is located approximately 100 m upstream of tidal influence, at a point 40 m downstream from the Seaview Road bridge, within Miracle Beach Provincial Park.

Black Creek is a low-gradient (approximately 0.6%) stream, and is approximately 26 km long, 5-6 m wide in its middle reaches, and has a catchment area of 72.5 km^2. For most of its length it meanders through agricultural land, small lakes (including Northy Lake), swampy areas, and beaver ponds. In the lower watershed, there are several tributaries including Millar Creek, a tributary to Northy Lake. Maximum discharges of 50-60 m^3/s have been estimated during floods. Black Creek supports populations of coho salmon, coastal cutthroat trout (*O. clarki*), and rainbow trout (*O. mykiss*). Coho spawn throughout the watershed, but the best spawning grounds are in Millar Creek, in mainstem areas adjacent to the Sturgess Road bridge, and in the upper reaches in the vicinity of the Duncan Main logging road (Nelson, 1996).

The Black Creek Project was initiated in 1984 as part of an investigation of the degree of similarity of the biological attributes and exploitation patterns of the coho populations of Black Creek, French Creek, and Trent River (Labelle, 1990). The project changed direction in 1988 when investigations focused on escapement enumeration methods and was concluded in 1995 (Bocking et al., 1988; Fielding et al., 1989; Bocking et al., 1991; Bocking et al., 1992; Nass et al., 1993a; Nass et al., 1993b; Nelson et al., 1994a; Nelson et al., 1994b; Nelson et al., 1995; and Nelson et al., 1996). In 1995, the Black Creek project was reduced in scope and currently is used to investigate coho contributions to the commercial and recreational fisheries, and the data collected is used as a stock assessment tool for the south coast region of British Columbia (Nelson and Simpson, 1996).

METHODS

Fence Structure

In the Spring of 1995, the project managers decided to build a new fence structure, based on the Carnation Creek Fence (Lill and Sookachoff, 1974). The new structure can be used for both smolt (spring) and adult (fall) operations. The structure is composed of aluminum I-beams placed on vertical supports, approximately 1.5 m above the cement deck, to provide a horizontal surface for a catwalk platform. A walkway composed of aluminum grates is bolted to the beams. I-Beams are also placed on an angle from the upstream edge of the catwalk, down to the cement deck at an angle of 40^{O} from the horizontal. The platform provides a working surface for the cleaning of the angled panels or grates. Each set of I-beams was placed 1.6 m apart.

Alterations to the cement deck were carried out in the low flow period in July 1995. The apron was extended downstream by approximately 1 m. Anchor sockets were installed in the deck for attaching the aluminum uprights and angle aluminum, to which the sloped I-beams would be bolted. In October 1996, angle aluminum was installed so that the uprights could be bolted to a permanent member rather than to the anchors, which are not designed for repetitive use.

During spring operations, a 1.2 x 1.5 m panel of 5.2 mm stainless steel screening is placed between each opening. A single opening is closed off with a piece of 1.9 mm plywood, into which is a length of unperforated 15 cm "Big O" pipe. The pipe drains downstream into a set of traps/holding boxes where the trapped fish are collected.

During fall operations, a 2.4 x 1.5 m steel grate, with 1.9 mm spaces between the flat bar, is placed in each opening. There are two sections where an opening allows the adult fish to pass through a wooden tunnel and into a holding trap immediately upstream of the fence. The entrance to the trap can be closed off to prevent the trapped fish to escape downstream before they can be netted and sampled. The trap structures have been used for several years at this site.

During the fall 1995 and spring 1996 operations, the fence was cleaned using rakes and hoes, a labourious duty especially during high water events. For the fall 1996 operation, a high pressure washer was obtained which assisted in keeping the grates clean, although bigleaf maple (*Acer macrophyllum*) leaves proved to be too tough for the washer to shred.

Water Observations

Water temperature and level were recorded daily at or about 8:00 am. Water temperature was taken with a pocket thermometer (± 0.5 ^{O}C) from the flowing water at the fence site. Water level was read from a staff gauge (± 0.005 m) located approximately 250 m upstream of the fence site. Subjective weather conditions were also recorded daily, i.e. rain, clouds, windy, etc.

Smolt Operations

The traps were inspected and emptied daily at 8:00 am and the fish were sorted to species into buckets. A sample of 100 coho smolts per day were randomly selected and measured for fork length (± 1 mm). Twice during the sample period (1-May-96 and 23-May-96) up to 10 lengths and weights (± 0.1 g) were taken per 5 mm length group. Also twice during the sample period a scale smear was taken from up to 15 coho smolts per 5 mm length group.

Aging of the scale smears was done by the Fish Aging Unit at the Pacific Biological Station in Nanaimo, BC. Fish ages are represented by **X.Y**, where X represents the number of fresh water annuli, and Y represents the number of marine annuli. Each annulus marks a winter season, thus a fry would be age 0.0, a typical smolt, having spent one year in fresh water, would be age 1.0, as

would a typical jack, returning that fall. A typical adult, returning the following year, would be age 1.1.

All coho smolts were injected with a CWT which was applied with either a MK IV or a MK II Tagging Unit (Northwest Marine Technologies, Shaw Island, WA 98286) and the adipose fin was clipped to indicate the presence of the CWT. Three tag retention tests (n=300) were done over a 24 hour period to estimate the number of CWT'd coho smolts that would lose their tag over this period. Tagged coho were placed into a floating holding box to recover from the operation, and released periodically through the day. Untagged coho ('rejected') were tested for tags a second time, then retagged. Moribund fish were released untagged.

In previous years, smolts were divided into smalls (<120 mm) and larges (≥120 mm) and tagged with different codes. This procedure was not continued in 1996.

Other salmonids were noted as to species, fork length (± 5 mm) and whether they had a fin clip. All salmonids were anesthetized with tricaine methanesulfonate (MS-222). Coho fry were not included with the results because the screen size used on traps and panels was too coarse for them to be caught. All fence and trap mortalities were retained for sex determination, but the pieces were too decomposed for accurate results.

Adult Operations

The traps were inspected at 8:00 am, and periodically through the day as conditions warranted. Individual fish were netted from the trap and sampled. For each coho, sex (female, male, or jack), postorbital-hypural length (POH)(± 1 mm), any fin clips or external marks were noted, and a tag and operculum punch were applied. In 1995, chick wing tags (No. 1 size, Ketchum Manufacturing, 396 Berkley Ave., Ottawa, ON) were clamped around the posterior edge of the operculum. In 1996 clear anchor tags (FD-94, 2 in., Floy Tag & Manufacturing, 4616 Union Bay Pl., Seattle, WA, 98105) were inserted into the muscle tissue, lateral to the dorsal fin.

The designation of precocial male ('jack') was based on length (≤ 350 mm POH), and appearance.

In 1995, for 10 males and 20 females for every 5 cm size class, fork length (± 1 mm) and weight (± 0.05 kg) was recorded. Scale samples were taken at the rate of 5 coho per 5 cm size class, for classes ≤ 40 cm, and 15 coho per 5 cm size class, for classes > 40 cm. Every 10th adipose-clipped jack was sacrificed and frozen for CWT analysis. In 1996, there were very few spawners, so virtually all coho were measured for fork length, weighed and a scale sample was taken from most. Every 10th adipose-clipped jack was sacrificed and frozen for CWT analysis.

Spawning grounds were inspected frequently after the peak of movement through the fence for collection of spawned out carcasses for CWT analysis and occurrence of salmon that passed by the fence undetected and unsampled.

For other salmonids, species, fork length (± 1 mm), and presence/absence of a fin clip were noted.

RESULTS

Fall 1995

The fall 1995 operation was the first use of the new fence structure using the permanent framework and grate panels.

Water observations are presented in Table 2.1 and Figure 2.1. The fall of 1995 operation started with water levels too low for fish passage. By the time the first fall storms started, the fence was installed and fishing on 11 October. Water levels remained at normal fall levels until mid-November when excessive rainfall damaged the west dyke, causing it to fail on 8 November. The dyke was immediately rebuilt, and was washed away again on 20 November. There was opportunity for fish passage around the fence and traps, though most of the migration would have happened previously, in mid-October. When the crew was inspecting the spawning areas for carcasses, data was collected on tagged and untagged fish to determine how many were able to escape detection.

The first coho were trapped on October 13. The coho moved into the system in three pulses, 13-19 October (70%), 25-28 October (25%) and 13 - 16 November (5%). These periods are associated with storm events, where water levels were rising. The third pulse occurred after the dyke had been washed away, and was rebuilt. The fence was shut down on 20 November when the dyke was washed away again. The last recorded coho adult was processed on 16 November (Table 2.2, Figure 2.2).

A total of 831 female, 778 male, and 1150 jack coho were enumerated through the fence of which 826 female, 759 male, and 1142 jack coho were measured for POH (Table 2.3). 143 female, and 73 male were measured for fork length, and 46 female and 45 male coho were weighed (Table 2.4). The mean length and weight of female coho was POH 522 mm (S.D.= 59.8), fork 634 mm (S.D.=72.9), and weight 3.50 kg (S.D.=1.27). The mean length and weight of male coho was POH 478 mm (S.D.=78.2), fork 616 (S.D.=113.7), and weight 2.97 kg (S.D.=1.42). The mean length of jack coho was POH 278 mm (S.D.=27.9). The linear regression to describe the relationship of POH to Fork Length was calculated as:

Females	(FL) = 1.220(POH)	(1.216 - 1.225)
Males	(FL) = 1.252(POH)	(1.242 - 1.262)

Adipose clips were observed on 705 (84.8%) females, 652 (83.8%) of the males and 1077 (93.7%) of the jacks.

Due to the method of jack designation, there is a very sharp break in the length frequency distribution between the jack and adult male coho (Figure 2.3). There is certainly some misclassed individuals. 3 of 7 jacks that were successfully aged from the fence sample were 1.1, so were redesignated as males. There were no age 1.1 'jacks' in the successfully aged, sacrificed sample (n=61), but one of the unsuccessfully aged jacks had a CWT code that would have been on an age 1.1 fish. There were no misclassed jacks in the carcass samples (n=2) (Table 2.5, showing the corrected designations).

Table 2.6 shows the results of the CWT recovery from the jack and carcass samples, and table 2.7 summarized the data, and presents the return rate. The number of tags released is from Nelson et at., 1996 and Nelson and Simpson, 1996. The table is separated into adults (females and males) and jacks, into smolt size at the time of tagging ($<$ and $\geq$ 120 mm), and in chronological order of tag code used. For adults, the smaller smolt size showed higher % returns than the larger smolt size. For jacks, the larger smolt size showed the higher % return. And for both types of adults, the early codes show a higher return than the later codes.

Table 2.8 shows the results from the carcass surveys. Adipose clips were found on 89.0% of the adult carcasses (n=55) and all of the jack carcasses (n=7). Opercular punches were observed on 90.4% of the adult carcasses (n=52, three unknown) and all of the jack carcasses (n=7). From this data an escapement of 1760 adults (95% highest probability range,1626-2038) is computed using Baysean Estimation techniques (J.A. Taylor, pers. com.). The ratio of females:males seen at the fence is used to estimate the final number of 910 females and 850 males (Table 1.1)

Table 2.9 shows the location of coded wire tag recoveries (expanded by subsampling rate) in the commercial and sport fisheries in Canada and USA. The summary at the bottom of the table shows the calculation of a marine survival of 4.5% and a marine exploitation rate of 56.5%.

Spring 1996

The Spring 1996 operation used the new fence structure with screened panels. Initially, smolt traps were operated on the upstream side of the structure, but the water flow proved to be difficult to regulate, and were abandoned in favour of traditional traps located downstream of the structure. There was some mortalities associated with the original smolt traps, which ceased to be a problem when the downstream traps were activated.

Operations commenced on 27 April and ceased on 13 June. The start date was later than the usual start date of around 22 April due to problems in installing the new panels used this year. As a result the early part of the smolt run will have passed by the fence undetected.

Table 3.1 and Figure 3.1 show the results of water observations at the fence site. Water levels were high initially and gradually dropped over the observation period. There were several storm events during the mid-May period but fence integrity was kept throughout. It was noted by the field crew that the style of fence that was used in previous years would have been 'washed out' during the May storm event, and smolts would have passed by undetected. The highest daily total of smolts occurred on the first day of the storm, 1850 on 13 May.

Table 3.2 shows the daily counts of all salmonid species that were caught in the smolt trap, with coho smolts broken down into mortalities, CWT'd and untagged releases. Cutthroat Trout are noted as to fin clipped or not. Figure 3.2 shows the total daily count of coho smolt migration. Table 3.3 contains the daily coho length data, and Figure 3.3 depicts the data. A series of weights were taken in two periods, and the results are described by the equations:

2-May-96 Length-weight relationship	Ln(weight) = 2.9(Ln(length)) - 11.1
23-May-96 Length-weight relationship	Ln(weight) = 3.0(Ln(length)) - 11.7

A total of 14,178 coho smolts were captured in the traps, of which 286 died prior to tagging (mostly trap morts) and 27 died after tagging. 13,828 were coded-wire tagged and released, 27 were released untagged, and 10 were given to the Miracle Beach Provincial Park for their interpretation centre.

Age data is presented in Table 3.4 and follows Ketchen's Stratified Subsampling Method (Ricker, 1975). 99.3% of the smolt run is estimated to be age 1.0. Table 3.5 presents length data based on age which shows that age 2.0 smolts are larger age 1.0 smolts, as expected.

Table 3.6 shows the results from three tag retention tests, with 298/300 (99.3%) coho retaining the CWTs. Table 3.7 presents the CWT release data by code. 9664 tags were released (after adjustment for mortalities and tag loss) from code 080813, and 4045 tags were released from code 080814. Table 3.8 shows the CWT sequential numbers for tags taken before and after tagging the smolts each day and the period of time each tag code was used.

Coho fry and other species were not noted.

Fall 1996

Water observations are presented in Table 4.1 and depicted in Figure 4.1 Generally, water levels stayed at moderate heights throughout the sampling period, with a major storm event around 7 November. During all operations, fence and dyke integrity was kept and no adult fish were able to bypass the fence and traps. During the high water event, it was possible for jack size fish to pass through a gap in the lid to the trap, and one jack carcass was recovered without a punch or tag, and another tagged, punched jack was recovered in the Oyster River fish trap.

Fence operations began on 18 October. Prior to this date, there was enough water for fish passage, but there were no observed fish in the system. Initial fence enumeration indicates that a number of jacks likely entered before this date, but adults were not numerous. The first fish were recorded on 18 October and the last was recorded on 14 November and the fence was removed on 30 November. The coho moved into the system in two periods, first in mid to late October, then in mid November (Table 4.2 and Figure 4.2). A total of 65 female, 82 male, and 329 jack coho salmon were counted, and 84 cutthroat and 1 rainbow trout, and 2 chum salmon (*O. keta*) were also counted. 66.2% of the females, 62.2% of the males and 16.1% of the jacks were adipose clipped, indicating the presence of a CWT.

142 adults and 311 jacks were tagged at the fence with an external anchor tag. Unfortunately very few carcasses were recovered therefore a poor mark recapture estimate has been calculated. 2 adults were recovered, of which one was anchor tagged, therefore the escapement was found by applying the mark recapture rate (50%) to the number of anchor tagged coho for an estimate of 284. 12 jacks were recovered of which 5 were tagged. Using a Peterson formula, an escapement of 678 jacks, +/- 367 (95% range) is estimated. Using the ratio of males:females observed at the weir, the escapement is divided into 126 females and 158 males.

45 female, 64 male, and 272 jack coho were measured for POH (Table 4.3 and Figure 4.3). 45 female, 61 male and 123 jack coho were measured for fork length, and 46 female, 61 male and 115 jack coho were weighed (Table 4.4). The mean length and weight of female coho was POH 504 mm (S.D.= 47.4), fork 620 mm (S.D.=56.0), and weight 3.00 kg (S.D.=0.89). The mean length and weight of male coho was POH 424 mm (S.D.=75.7), fork 541 mm (S.D.=98.0), and weight 2.02 kg (S.D.=1.13). The mean length and weight of jack coho was POH 265 mm (S.D.=26.5), fork 332 mm (S.D.=34.2), and weight 0.51 kg (S.D.=0.153). The linear regression to describe the relationship of POH to Fork Length was calculated as, with 95% confidence interval for the regression coefficient:

Females	(FL) = 1.235 (POH)	(1.226 - 1.243)
Males	(FL) = 1.265 (POH)	(1.253 - 1.276)
Jacks	(FL) = 1.238 (POH)	(1.228 - 1.247)

Age data are presented in Table 4.5. Scale samples were only collected on coho adults that were sampled at the fence, and not on the sacrificed jacks, or the carcasses. There were seven scale samples that were taken from coho designated as jacks at the fence, but were aged to be full adults. The designation was changed in the data for those particular fish, and presented here as corrected. As seen in Table 4.5, 95.0% of the jacks, 91% of the males, and 88% of the females were one year old smolts.

Table 4.6 shows the results from the CWT sampling, from the fence jack samples and the carcass recovery. Due to the low numbers of coho in the escapement, very few carcasses were seen, consequently there were only two jacks and one female recovered with a tag. Table 4.7 summarizes the CWT recoveries and survival rates and Table 4.8 summarizes the carcass surveys. One of two adults recovered was adipose clipped and contained a CWT, and 2 of 12 jacks were clipped and tagged.

An anchor tagged jack was recovered in the Oyster River fish trap on 11 December 1996 (Bryan Allen, pers. Comm.) with the tag # 96-1862. This fish was tagged at the Black Creek fence on 22 October 1996 and probably passed back through the fence during the 8 November 1996 storm.

Table 4.9 shows the location of coded wire tag recoveries (expanded by subsampling rate) in the commercial and sport fisheries in Canada and USA. The summary at the bottom of the table shows the calculation of a marine survival of 3.4% and a marine exploitation rate of 70.2%.

DISCUSSION

Fall 1995

The fall 1995 program was highlighted by strong winter storms at the conclusion of the spawning migration. While this resulted in undetected passage of adult coho, there were very few available to pass by the fence at that time. Most of the run had already entered the system. The estimate of the escapement was calculated using the Bayesian estimation technique because it provides the best estimate, given the non-random application of marks, and the low probability of recapture. An estimate of the number of jacks is not possible due to the lack of recoveries. The observed number at the fence is assumed to be the escapement. For more information on Bayesian estimation techniques, see Gazey and Staley, 1986.

The storms did hinder recovery of carcasses. Water levels were high during this period, causing carcasses and post-spawn fish to move downstream away from the known spawning areas. As a result, only 62 carcasses were recovered. There were also 3 carcasses recovered from the Oyster River, in a tributary in the golf course. These fish were observed to be adipose clipped and were recovered for CWT analysis, which showed them to be of Black Creek origin. The Oyster River enters the Strait of Georgia approximately 2.5 kilometers north of Black Creek.

67 jack scale samples were aged successfully (4 from fence samples, 61 from sacrificed samples, 2 from carcass recovery). Of the fence and sacrifice samples, 16.9% (11/65) were age 2.0. Previous reports (Bocking et al., 1992; Nass et al., 1993a; Nelson et at., 1994b; and Nelson et al., 1994a) indicate that large smolts (≥120 mm) have a higher incidence of returning as jacks, and that this tendency is more pronounced at the beginning of the smolt migration period, where the average size is highest. This information is also supported by the results from 1995 returns, where it was found that the highest proportion return of jacks came from early, large smolts and adults from early, small smolts

99 adult scale samples were aged successfully (68 from fence samples, 31 from carcass recovery). Of the fence samples 98.5% were age 1.1 (67/68), and the rest were age 2.1. Of the jack sacrifice samples, 84% (51/61) were age 1.0.

Females were significantly larger than males ($t = 12.5$), which is consistent with results from previous years (Nelson et al., 1996).

The marine exploitation rate showed a continuation of the downward trend first observed in the early 1990s.

Spring 1996

The spring program was highlighted by a late start, low numbers of coho smolts and a new fence that withstood a major storm event. 14,178 coho smolts were caught in the traps, the lowest total on record. Though no fence efficiency tests were done, snorkel inspections were conducted to examine the fence for integrity, with no problems observed. Certainly the early part of the migration was missed, which will be seen as a low clip rate on the jack return in the fall 1996 run. In 1994 3.7% of the total smolt run occurred in the 6 days prior to 28 April, and in 1995, 3.2% of the total occurred in the 7 days prior. If a rough average of 3.5% is applied to 1996's total, then approximately 500 smolts were missed during this period because of the late start. Additionally, there is evidence that more smolts could be moving prior to 22 April. In 1992 it was estimated that 9% of the smolt run occurred in the second week of April (Nelson et al., 1994a).

Virtually all successfully aged smolts were age 1.0 in 1996. As has been shown in previous years, age 2.0 smolts tend to leave early, and this early movement would have been missed this year. It

is unknown if the weir that was installed in 1995 (see "1995 Weir Incident", Nelson et al., 1996b) would have had any effect on the age 2.0 smolts.

Fence and trap mortalities were unacceptably high (2.2% overall), and were associated with water turbulence inside the new trap boxes. Once the operation was switched to traditional traps located downstream of the fence structure, mortality rates dropped to acceptable levels.

Fall 1996

The Fall 1996 program was highlighted by the poorest escapement on record. The total of 284 adults was 32% of the previous low of 875 adults in 1987.

Fence and dyke integrity was not compromised during the fence period, so the fence count of 147 adults is considered to be accurate. Additional escapement will have entered the system prior to the installation of the fence.

The low mark rate of the jacks (16.1%) supports the assumption that the early migrating smolts, which have a higher tendency to return as jacks, were missed in the spring of 1996.

Fork length and post-orbital hypural lengths have been taken in 1995 and 1996 to establish a relationship for Black creek coho, so comparisons can be made using fork length with data from other systems. The regression coefficient for males has a broad overlap in the 95% confidence interval between the two years, and there is no significant difference between the variances (f = 1.41). The females showed a significant difference (f = 3.19), with no overlap in the 95% confidence intervals. For a given POH of 550 mm, this difference amounts to an 8 mm difference in FL. Despite the significant difference we have decided to combine the data from both years for each sex to produce the following conversion equations and 95% confidence interval:

Female	FL = 1.223(POH)	(1.219-1.227)
Male	FL = 1.257(POH)	(1.249-1.264)
Jack	FL = 1.237(POH)	(1.227-1.246)

Females were significantly larger than males (t = 7.5), which is consistent with results from previous years (Nelson et al., 1996).

98 of the scale samples were aged successfully, and 85 were age partially successfully. The partially aged samples indicated the marine life, but not the freshwater life. 95% (38/40) of the jacks were age 1.0. In the spring 1996 operation, which missed the early part of the migration, 99.3% of the smolts were age 1.0. 91% (30/33) of the males and 88% (22/25) of the females were age 1.1. In the spring 1995 operation, 94.9% of the smolts were age 1.0.

The marine survival is the lowest rate on record. The continuing high exploitation rates resulted in the lowest escapement on records as well.

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General Tables and Figures

Table 1.1 Enumeration of Coho Smolts and Adults from 1984-1996

Year	Juveniles		Adults	
	Smolts	Jacks[1]	Males	Females
1984	N/A	350	3175[2]	2815[2]
1985	50208	349	3176[2]	2816[2]
1986	38212[3]	483	2385	2433
1987	60909[3]	1071	422	363
1988	75401	396	1848	1274
1989	29862	613	1607	1665
1990	118897	1328	524	713
1991	53876	2373	1719	1849
1992	50271	2348	904	816
1993	65171	1502	570	389
1994	78282	1500	484	416
1995	18295	1150	850	910
1996	14178	678	158	126

[1]- early counts of jacks are biased low, due to undetected passage of jacks through the fence panels
[2]- estimated proportions of males and females
[3]- wild population supplemented by fry planting in previous summer

Figure 1.1 Map of Black Creek and Vancouver Island

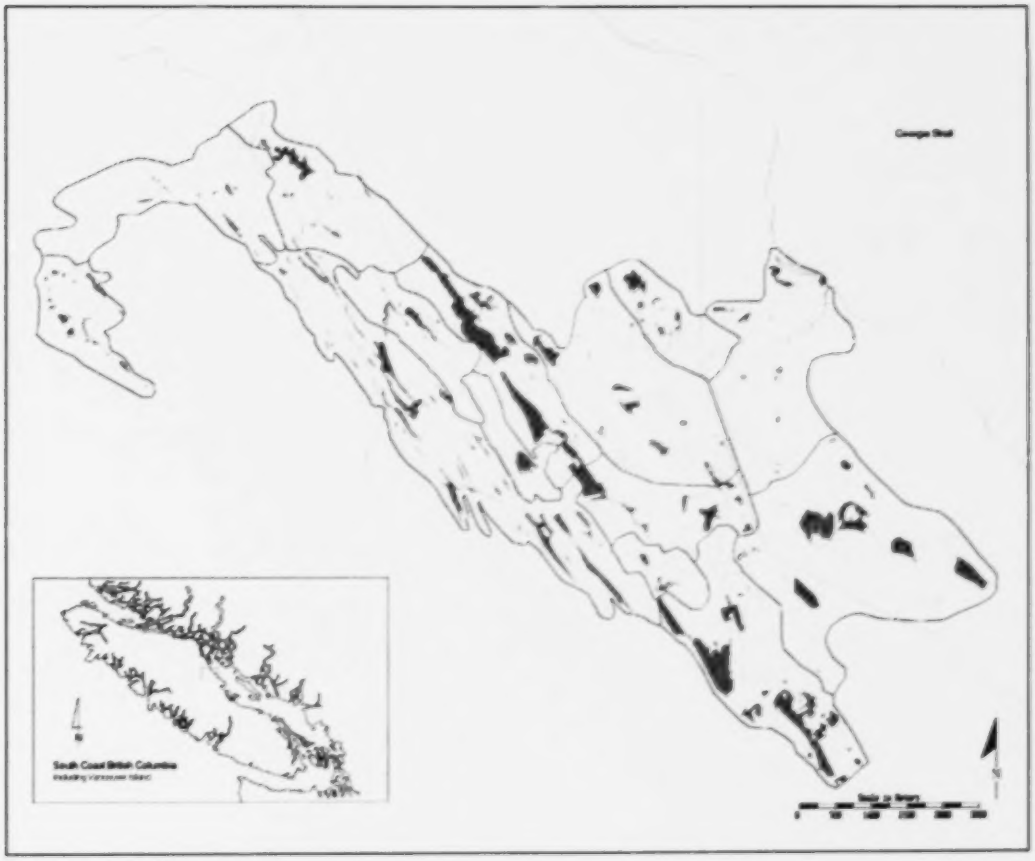
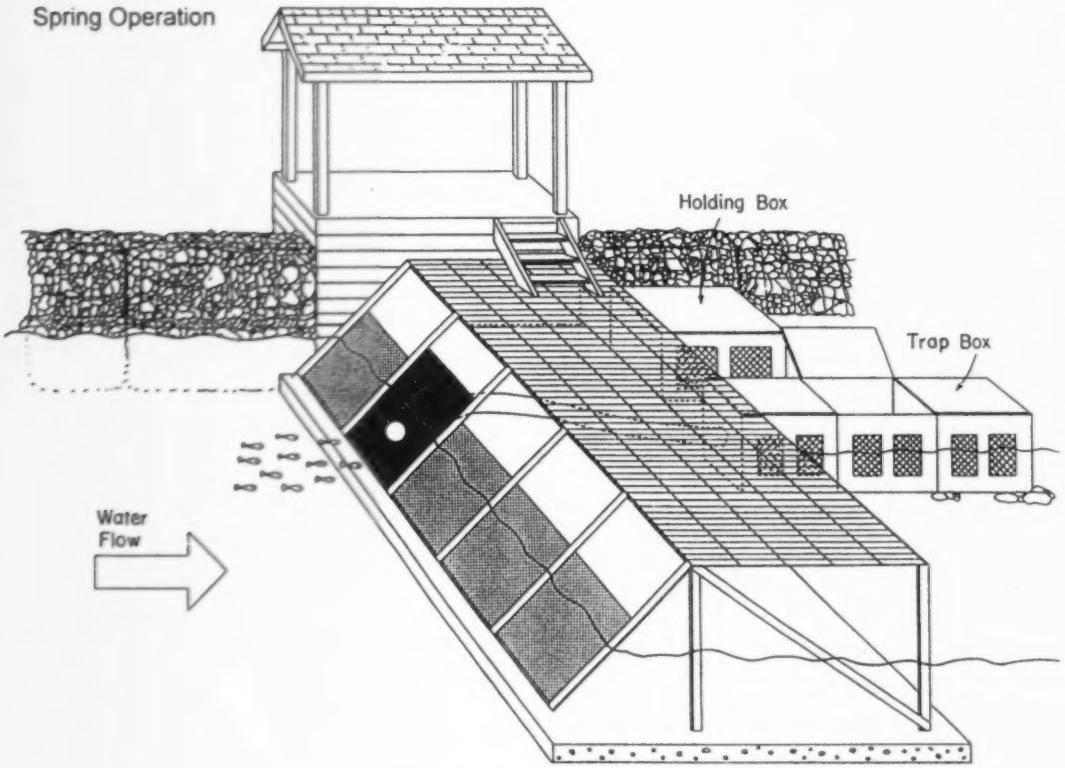
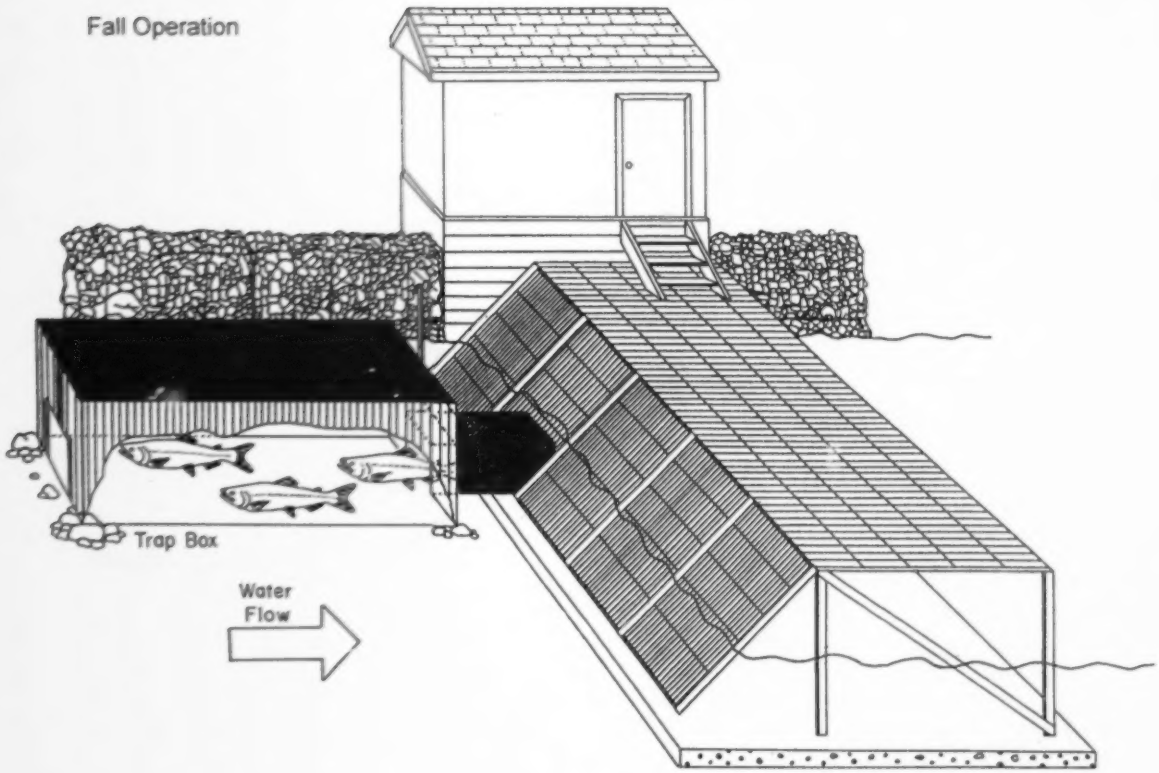


Figure 1.2 Images of new Black Creek fence structure.





Black Creek Fall 1995 Operations

Tables and Figures

Table 2.1 Water Observations

Date	Water Temperature	Water Level
12-Oct-95	9.0	41.5
13-Oct-95	10.0	42.5
14-Oct-95	11.0	65.0
15-Oct-95	10.5	59.0
16-Oct-95	11.0	73.0
17-Oct-95	11.0	76.0
18-Oct-95	9.0	87.5
19-Oct-95	8.5	77.0
20-Oct-95	8.5	71.5
21-Oct-95	8.0	66.0
22-Oct-95	8.0	61.5
23-Oct-95	8.5	57.5
24-Oct-95	8.5	56.5
25-Oct-95	8.5	54.0
26-Oct-95	8.0	101.0
27-Oct-95	8.0	92.0
28-Oct-95	8.0	83.0
29-Oct-95	5.5	74.0
30-Oct-95	5.0	68.5
31-Oct-95	4.0	65.0
01-Nov-95	4.0	61.0
02-Nov-95	4.0	58.0
03-Nov-95	4.0	55.5
04-Nov-95	5.0	53.0
05-Nov-95	4.5	52.0
06-Nov-95	4.0	50.0
07-Nov-95	9.0	80.0
08-Nov-95	7.0	141.5
09-Nov-95	5.0	115.0
10-Nov-95	4.5	107.0
11-Nov-95	7.0	154.0
12-Nov-95	7.0	142.0
13-Nov-95	6.0	130.0
14-Nov-95	6.5	121.5
15-Nov-95	8.0	106.5
16-Nov-95	7.0	95.0
17-Nov-95	8.5	140.0

Table 2.2 Daily Counts of all Species Through the Fence, by Sex

Date	Coho			CTT
	Females	Males	Jacks	
13-Oct-95	14	24	91	15
14-Oct-95	171	195	455	21
15-Oct-95	25	25	55	12
16-Oct-95	41	52	87	3
17-Oct-95	178	211	129	20
18-Oct-95	62	39	70	2
19-Oct-95	5	1	2	0
20-Oct-95	0	0	0	0
21-Oct-95	0	0	0	0
22-Oct-95	0	0	0	0
23-Oct-95	0	0	0	0
24-Oct-95	0	0	0	0
25-Oct-95	63	52	78	8
26-Oct-95	204	149	137	0
27-Oct-95	1	3	0	0
28-Oct-95	0	0	1	0
29-Oct-95	0	0	0	0
30-Oct-95	0	0	0	0
31-Oct-95	0	0	0	0
01-Nov-95	0	0	0	0
02-Nov-95	0	0	0	0
03-Nov-95	0	0	0	0
04-Nov-95	0	0	0	0
05-Nov-95	0	0	0	0
06-Nov-95	0	0	0	0
07-Nov-95	4	2	0	0
08-Nov-95	0	0	0	0
09-Nov-95	0	0	0	0
10-Nov-95	0	0	0	0
11-Nov-95	0	0	0	0
12-Nov-95	0	0	0	0
13-Nov-95	11	7	6	0
14-Nov-95	24	7	16	0
15-Nov-95	23	11	23	0
16-Nov-95	5	1	0	0
Total	831	778	1150	81
# of adipose clips	705	652	1077	21
% clipped	84.8	83.8	93.7	25.9

Table 2.3 Length Frequency Counts of Coho, by Sex

Length Range	Females	Males	Jacks
191 - 200	0	0	1
201 - 210	0	0	3
211 - 220	0	0	12
221 - 230	0	0	26
231 - 240	0	1	58
241 - 250	0	0	76
251 - 260	0	0	148
261 - 270	1	0	167
271 - 280	0	1	176
281 - 290	0	1	149
291 - 300	0	1	109
301 - 310	0	0	74
311 - 320	0	0	50
321 - 330	0	1	38
331 - 340	1	1	28
341 - 350	0	4	20
351 - 360	1	28	6
361 - 370	2	29	0
371 - 380	5	22	0
381 - 390	7	23	0
391 - 400	3	26	0
401 - 410	4	43	0
411 - 420	10	30	0
421 - 430	14	34	0
431 - 440	22	35	0
441 - 450	30	34	0
451 - 460	26	30	0
461 - 470	44	35	0
471 - 480	44	26	0
481 - 490	52	34	0
491 - 500	58	27	0
501 - 510	48	29	0
511 - 520	54	26	0
521 - 530	30	18	0
531 - 540	38	19	0
541 - 550	41	23	0
551 - 560	51	22	0
561 - 570	38	33	0
571 - 580	33	29	0
581 - 590	53	24	0
591 - 600	45	24	0
601 - 610	30	18	0
611 - 620	16	12	0
621 - 630	14	9	0
631 - 640	6	4	0
641 - 650	3	2	0
651 - 660	1	1	0
661 - 670	0	0	0
671 - 680	1	0	0
Total	826	759	1141

Table 2.4 Biological Data

POH Length	Female	Male	Jack
Count	826	759	1142
Average	522	478	278
StdDev	59.8	78.2	27.9
Max	671	659	356
Min	266	240	200

Fork Length	Female	Male	Jack
Count	143	73	
Average	634	616	
StdDev	72.9	113.7	
Max	780	805	
Minx	469	411	

Weight	Female	Male	Jack
Count	46	45	
Average	3.50	2.95	
StdDev	1.27	1.42	
Max	6.1	6.35	
Min	1.8	1.05	

Table 2.5 Age Data (corrected designations)

	Age	Jacks	Males	Females
Fence Data	1.0	3		
	1.1		29	38
	2.0	1		
	2.1			1
Jack Data	1.0	51		
	2.0	10		
Carcass Data	1.0	2		
	1.1		10	21

Table 2.6 CWT Results

Jack Sacrifice Samples				
CWT code	Seq #	Sex	Date	Location
80158	4808	M	16/10/95	Fence
80810	8809	J	14/10/95	Fence
80810	7056	J	14/10/95	Fence
80810	9653	J	14/10/95	Fence
80810	3286	J	14/10/95	Fence
80810	1877	J	14/10/95	Fence
80810	6459	J	14/10/95	Fence
80810	7455	J	14/10/95	Fence
80810	8429	J	14/10/95	Fence
80810	7090	J	14/10/95	Fence
80810	8013	J	14/10/95	Fence
80810	1208	J	14/10/95	Fence
80810	9584	J	14/10/95	Fence
80810	12190	J	15/10/95	Fence
80810	2786	J	15/10/95	Fence
80810	5003	J	15/10/95	Fence
80810	3741	J	15/10/95	Fence
80810	10483	J	16/10/95	Fence
80810	2239	J	16/10/95	Fence
80810	7548	J	16/10/95	Fence
80810	7193	J	16/10/95	Fence
80810	7361	J	16/10/95	Fence
80810	3081	J	16/10/95	Fence
80810	8173	J	16/10/95	Fence
80810	2453	J	16/10/95	Fence
80810	6560	J	16/10/95	Fence
80810	5991	J	16/10/95	Fence
80810	12241	J	16/10/95	Fence
80810	8729	J	16/10/95	Fence
80810	713	J	16/10/95	Fence
80810	4778	J	16/10/95	Fence
80810	7092	J	16/10/95	Fence
80810	7321	J	17/10/95	Fence
80810	1340	J	17/10/95	Fence
80810	10690	J	17/10/95	Fence
80810	3306	J	17/10/95	Fence
80810	8082	J	17/10/95	Fence
80810	12303	J	17/10/95	Fence
80810	6019	J	17/10/95	Fence
80810	8251	J	17/10/95	Fence
80810	5545	J	17/10/95	Fence
80810	10341	J	17/10/95	Fence
80810	4874	J	17/10/95	Fence
80810	10495	J	17/10/95	Fence
80810	3122	J	17/10/95	Fence
80810	1872	J	17/10/95	Fence
80810	5970	J	17/10/95	Fence
80810	2271	J	17/10/95	Fence

Table 2.6 (cont.)

CWT code	Seq #	Sex	Date	Location
80810	1616	J	17/10/95	Fence
80810	3175	J	17/10/95	Fence
80810	8421	J	17/10/95	Fence
80810	7683	J	17/10/95	Fence
80810	11111	J	18/10/95	Fence
80810	11239	J	18/10/95	Fence
80810	3086	J	18/10/95	Fence
80810	5358	J	25/10/95	Fence
80810	7162	J	25/10/95	Fence
80810	7317	J	25/10/95	Fence
80810	10146	J	25/10/95	Fence
80810	6383	J	25/10/95	Fence
80810	7458	J	26/10/95	Fence
80810	5867	J	26/10/95	Fence
80810	10024	J	26/10/95	Fence
80811	850	J	15/10/95	Fence
80812	2213	J	14/10/95	Fence
80812	3860	J	14/10/95	Fence
80812	2871	J	14/10/95	Fence
80812	3819	J	15/10/95	Fence
80812	2033	J	16/10/95	Fence
80812	3783	J	16/10/95	Fence
80812	2074	J	17/10/95	Fence
80812	7271	J	17/10/95	Fence
80812	2010	J	17/10/95	Fence
80812	4203	J	18/10/95	Fence
80812	3883	J	18/10/95	Fence
80812	6276	J	18/10/95	Fence
80812	6472	J	25/10/95	Fence
80812	3799	J	25/10/95	Fence
80812	2838	J	26/10/95	Fence

Carcass samples				
CWT code	Seq #	Sex	Date	Location
80810	3501	J	06/11/95	Creek
80810	1763	J	10/11/95	Fence
80810	862	J	27/11/95	Creek
80810	1836	J	28/11/95	Creek
80812	4356	J	06/12/95	Creek
80145	4649	F	02/11/95	Fence
80145	7451	F	06/11/95	Creek
80145	2560	F	06/11/95	Creek
80145	9745	F	20/11/95	Fence
80145	6929	F	27/11/95	Creek
80147	3167	F	06/11/95	Creek
80147	5786	F	06/11/95	Creek
80147	3289	M	06/11/95	Creek
80147	2154	F	27/11/95	Creek
80147	10114	F	28/11/95	Creek

Table 2.6 (cont.)

CWT code	Seq #	Sex	Date	Location
80147	2033	F	28/11/95	Creek
80147	2366	M	05/12/95	Creek
80148	3385	M	28/11/95	Creek
80149	7995	F	20/11/95	Fence
80149	7465	F	27/11/95	Creek
80149	7525	F	28/11/95	Creek
80149	4999	F	06/12/95	Creek
80149	4545	F	20/11/95	Oyster Trib
80149	2170	F	05/12/95	Oyster Trib
80154	4124	M	18/10/95	Fence
80154	5281	M	27/10/95	Fence
80154	1614	F	01/11/95	Creek
80154	1684	M	01/11/95	Creek
80154	3003	F	14/11/95	Fence
80154	8137	M	15/11/95	Fence
80154	8323	F	27/11/95	Creek
80154	2852	M	27/11/95	Creek
80154	1187	F	28/11/95	Creek
80154	8351	F	28/11/95	Creek
80154	14105	F	06/12/95	Creek
80154	10022	F	06/12/95	Creek
80154	11645	M	06/12/95	Creek
80155	10396	F	27/11/95	Creek
80155	9744	F	27/11/95	Creek
80155	10153	F	27/11/95	Creek
80155	5383	F	27/11/95	Creek
80155	7014	F	28/11/95	Creek
80155	9302	F	28/11/95	Creek
80155	12632	F	02/12/95	Creek
80155	3681	F	06/12/95	Creek
80155	1798	F	06/12/95	Creek
80155	9202	F	06/12/95	Creek
80156	9029	M	16/11/95	Fence
80156	8393	M	28/11/95	Creek
80157	6622	M	06/11/95	Creek
80157	3439	F	06/12/95	Creek
80157	5211	F	06/12/95	Creek
80157	5932	M	06/12/95	Creek
80158	7625	F	27/11/95	Creek
80158	3242	F	05/12/95	Creek

Table 2.7 Summary of CWT recoveries in Black Creek

CWT Code	Type	Observed CWT			Estimated CWT			Tags released	Proportion Survival		
		Female	Male	Jack	Female	Male	Jack		Female	Male	Jack
080149	sm1	6	0		114	0		8305	0.028		
080154	sm2	7	6		133	279		9685	0.028	0.058	
080155	sm3	10	0		191	0		10121	0.038		
080157	sm4	2	2		38	93		8919	0.009	0.021	
080158	sm5	2	1		38	47		4634	0.016	0.020	
080145	lg1	5	0		95	0		10817	0.018		
080147	lg2	5	2		95	93		8983	0.021	0.021	
080148	lg3	0	1		0	47		9728		0.010	
080156	lg4	0	2		0	93		6680		0.028	
080811	sm			1			13	2700			0.010
080810	lg1			66			856	9344			0.183
080812	lg2			16			208	6164			0.067

[1] - sm refers to smolts < 120 mm, lg refers to smolts ≥120 mm. The number refers to the chronological order in which the tag codes were used (i.e. 1 is earliest)

Table 2.8 Results of Carcass Surveys

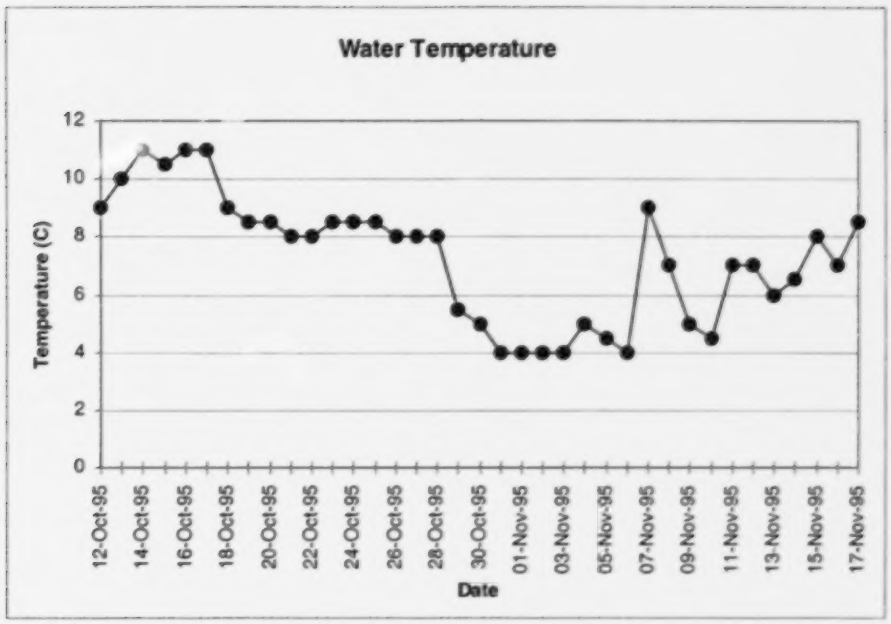
Date	Location	Sex	POH (mm)	Fin Clip	Operculum Punch
18/10/95	Fence	M	482	Ad	Yes
27/10/95	Fence	J	335	Ad	Yes
01/11/95	Creek	F	601	Ad	Yes
01/11/95	Creek	M	360	Ad	Yes
02/11/95	Fence	F	643	Ad	Yes
06/11/95	Creek	F	526	Ad	Yes
06/11/95	Creek	F	522	Ad	Yes
06/11/95	Creek	F	467	Ad	Yes
06/11/95	Creek	F	532	Ad	Yes
06/11/95	Creek	F	578		Yes
06/11/95	Creek	J	271	Ad	Yes
06/11/95	Creek	M	473	Ad	Yes
06/11/95	Creek	M	402	Ad	Yes
10/11/95	Fence	J	260	Ad	Yes
14/11/95	Fence	F	527	Ad	Yes
15/11/95	Fence	M	349	Ad	Yes
16/11/95	Fence	M	388	Ad	Yes
16/11/95	Fence	M	413		Yes
20/11/95	Fence	F	596	Ad	Yes
20/11/95	Fence	F	580	Ad	Yes
20/11/95	Fence	M	428		Yes
27/11/95	Creek	F	551	Ad	Yes
27/11/95	Creek	F	582	Ad	Yes
27/11/95	Creek	F	406	Ad	Yes
27/11/95	Creek	F	467	Ad	Yes
27/11/95	Creek	F	476	Ad	Yes
27/11/95	Creek	F	547	Ad	Yes
27/11/95	Creek	F	498	Ad	Yes
27/11/95	Creek	F	563	Ad	No
27/11/95	Creek	F	454	Ad	No
27/11/95	Creek	J	283	Ad	Yes
27/11/95	Creek	M	445	Ad	Yes
28/11/95	Creek	F		Ad	?
28/11/95	Creek	F	476	Ad	Yes
28/11/95	Creek	F	527	Ad	Yes
28/11/95	Creek	F	572	Ad	Yes
28/11/95	Creek	F	528	Ad	Yes
28/11/95	Creek	F	521	Ad	Yes
28/11/95	Creek	F	588	Ad	Yes
28/11/95	Creek	F	519	Ad	No
28/11/95	Creek	J		Ad	Yes
28/11/95	Creek	M		Ad	?
28/11/95	Creek	M	563	Ad	Yes
28/11/95	Creek	M	595		Yes
28/11/95	Creek	M			Yes
28/11/95	Creek	M	534	Ad	Yes
02/12/95	Creek	F	559	Ad	Yes
02/12/95	Creek	F	491		Yes

Table 2.8 (cont.)

Date	Location	Sex	POH (mm)	Fin Clip	Operculum Punch
05/12/95	Creek	F	428	Ad	No
05/12/95	Creek	M	557	Ad	Yes
06/12/95	Creek	F		Ad	?
06/12/95	Creek	F	477	Ad	Yes
06/12/95	Creek	F	457	Ad	Yes
06/12/95	Creek	F	402	Ad	Yes
06/12/95	Creek	F	561	Ad	Yes
06/12/95	Creek	F	453	Ad	Yes
06/12/95	Creek	F		Ad	Yes
06/12/95	Creek	F	584	Ad	No
06/12/95	Creek	J	349	Ad	Yes
06/12/95	Creek	J	270	Ad	Yes
06/12/95	Creek	M		Ad	Yes
06/12/95	Creek	M		Ad	Yes
20/11/95	Oyster River	F	534	Ad	No
20/11/95	Oyster River	F	550	Ad	No
05/12/95	Oyster River	F	600	Ad	No

Table 2.9 Estimated return of coded-wire tag coho in 1995.

Tagged Release (1994)		76,107
Escapement		1,495
Catch Region:		
FWSP	FWSP	10
Net	CN	30
	FGN	-
	GSN	-
	JFN	34
	JSN	155
	NN	11
	SWVN	1
Sport	ACSPT	-
	CSPT	66
	GSPTN	93
	GSPTS	-
	JFSPT	47
	WSPT	67
Troll	GSTR	-
	NCTR	13
	NTR	73
	NWTR	420
	SCTR	19
	SWTR	635
US	AK	203
	US South	87
	Total Return	3,459
	Total Catch	1,964
	Survival	4.5
	Exploitation Rate	56.8
	Marine Exploitation Rate	56.5
	% Inside	5.0



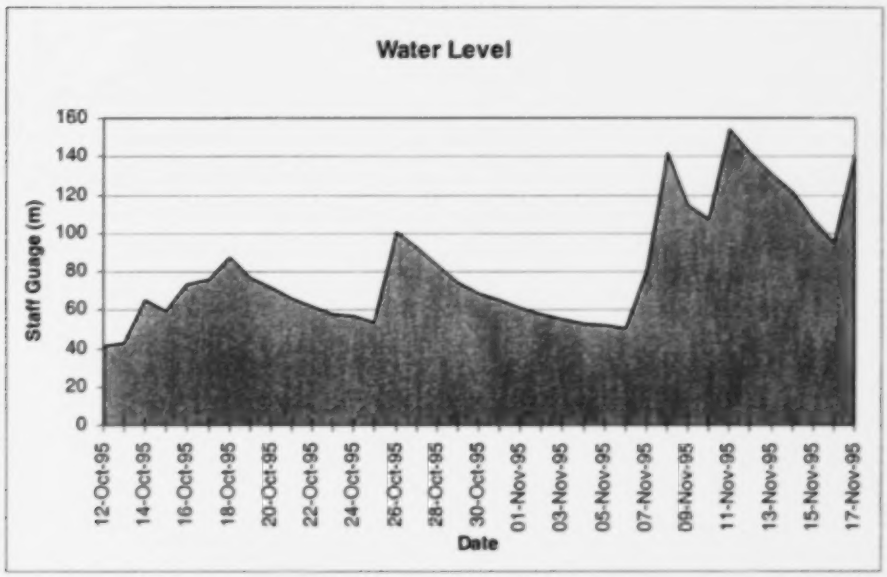


Figure 2.1 Water Observations

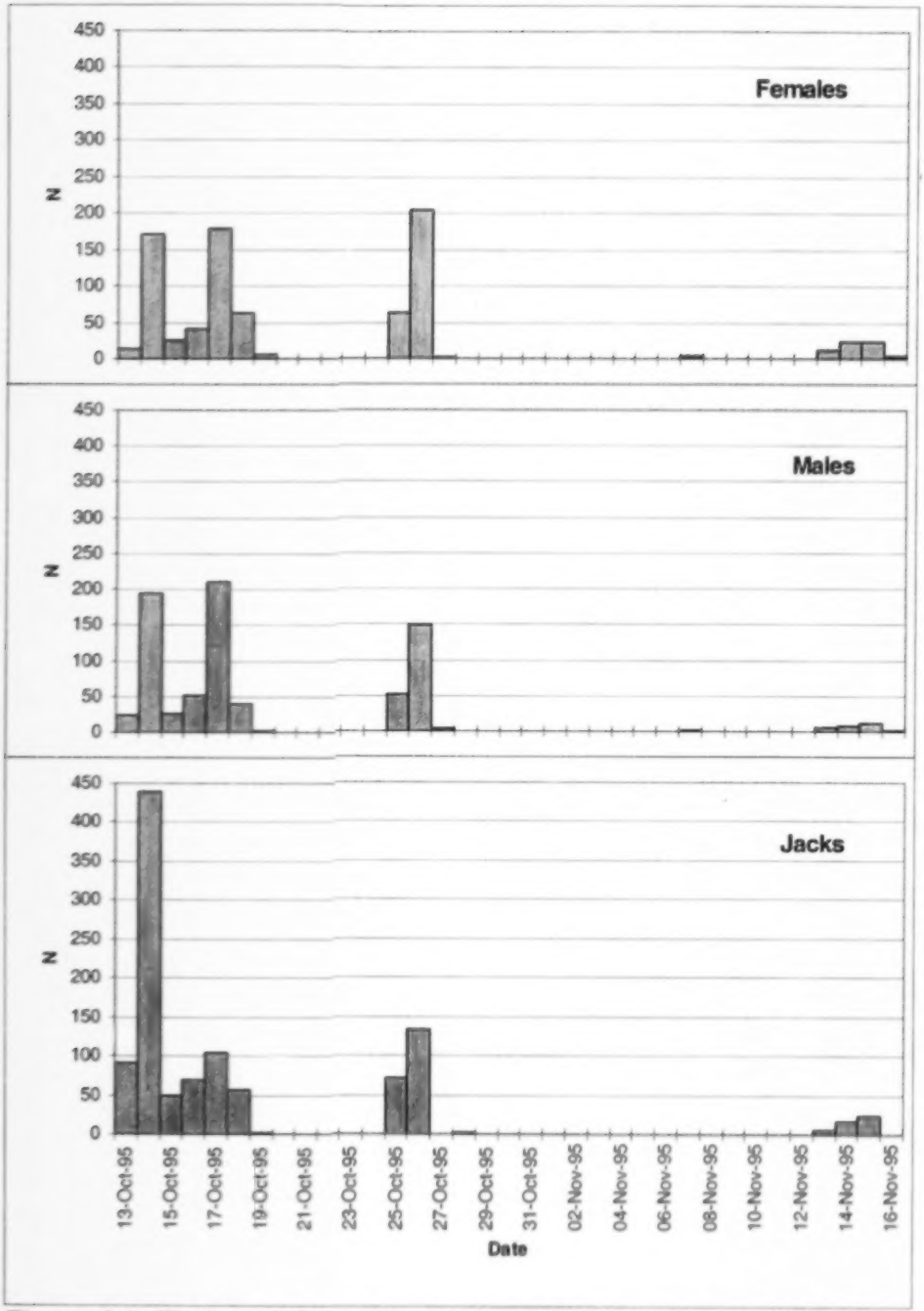
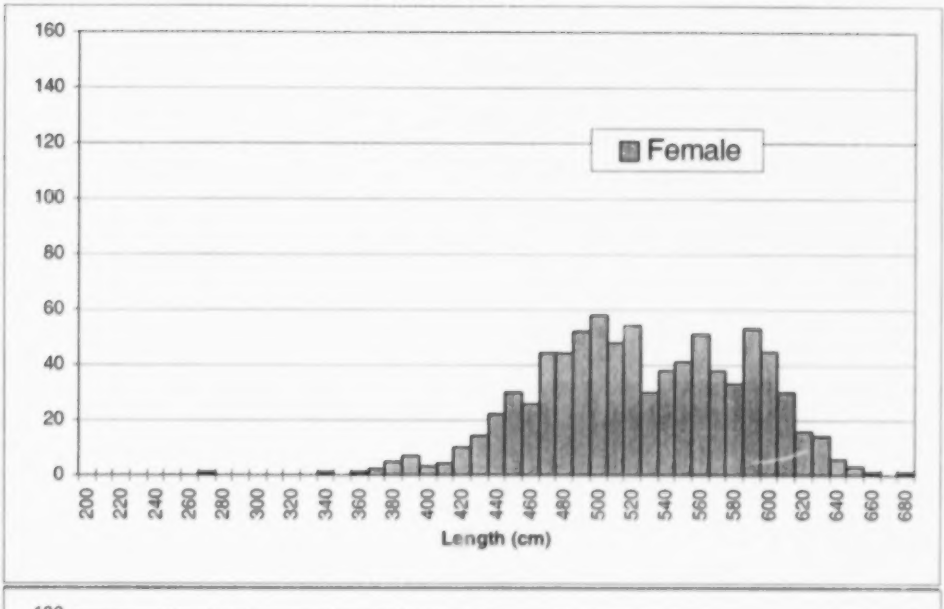


Figure 2.2 Timing of Coho Through Black Creek Fence, by Sex



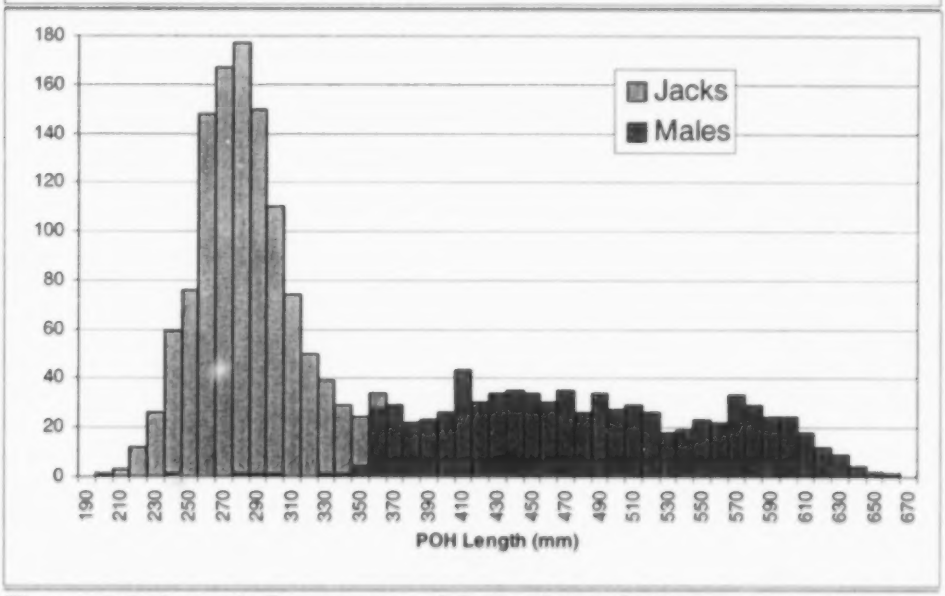


Figure 2.3 Length Frequency of Coho Adult Salmon

Black Creek Spring 1996 Operations

Tables and Figures

Table 3.1 Water Observations

Date	Water Temperature (°C)	Water Level (m)
28-Apr-96	9.0	0.780
29-Apr-96	8.5	0.760
30-Apr-96	9.0	0.720
01-May-96	9.0	0.720
02-May-96	9.0	0.700
03-May-96	9.5	0.650
04-May-96	7.0	0.610
05-May-96	9.0	0.580
06-May-96	9.5	0.570
07-May-96	9.0	0.560
08-May-96	10.0	0.550
09-May-96	10.0	0.515
10-May-96	9.5	0.525
11-May-96	9.5	0.495
12-May-96	10.0	0.515
13-May-96	12.0	0.605
14-May-96	11.0	0.730
15-May-96	10.5	
16-May-96	11.0	0.560
17-May-96	11.0	0.530
18-May-96	11.0	0.605
19-May-96	11.0	0.585
20-May-96	11.0	0.555
21-May-96	10.0	0.570
22-May-96	12.0	0.560
23-May-96	12.0	0.575
24-May-96	12.0	0.540
25-May-96	14.0	0.520
26-May-96	12.0	0.480
27-May-96	13.0	0.440
28-May-96	12.0	0.430
29-May-96	12.0	0.425
30-May-96	13.5	0.400
31-May-96	13.5	0.405
01-Jun-96	14.0	0.380
02-Jun-96	14.5	0.370
03-Jun-96	15.0	0.365
04-Jun-96	14.5	0.360
05-Jun-96	12.5	0.345
06-Jun-96	14.0	0.335
07-Jun-96	14.0	0.350
08-Jun-96	14.0	0.325
09-Jun-96	13.0	0.310
10-Jun-96	13.0	
11-Jun-96	13.5	0.300
12-Jun-96	12.0	0.315
13-Jun-96	13.0	

Table 3.2 Daily Counts of all Species Through the Fence

Date	COHO					CTT		RBT
	live	morts	cwt'd	cwt'd morts	uncwt'd	with clip	no clip	
28-Apr-96	633	67	551	3	12			
29-Apr-96	754	27	715	2	10	2	9	3
30-Apr-96	178	10	168			3	23	2
01-May-96	285	15	268	2		12	32	4
02-May-96	172	13	153	5	1	6	9	
03-May-96	41	1	40			2	4	
04-May-96	58		58			2	3	
05-May-96	85		85			3	2	
06-May-96	38	4	34			5	3	
07-May-96	1172	24	1142	6		35	28	5
08-May-96	1305	96	1201	8		29	60	3
09-May-96	221		221			10	17	3
10-May-96	268		268			10	11	
11-May-96	670		669	1		38	47	3
12-May-96	783		783			18	24	3
13-May-96	1850	5	1845			14	36	1
14-May-96	146		146			6	9	
15-May-96	63	5	58					
16-May-96	149	4	145			10	12	3
17-May-96	482		482			18	6	2
18-May-96	220	8	212			2	1	
19-May-96	233		233			5	6	3
20-May-96	281	2	279			13	3	1
21-May-96	83		83			2	2	
22-May-96	199		199			2	4	2
23-May-96	339		339			7	4	4
24-May-96	433		423		10	5	2	2
25-May-96	92	2	90			3	7	3
26-May-96	215		215			7	3	6
27-May-96	350		349		1	12	7	13
28-May-96	202	1	201			7	3	6
29-May-96	209		209			4	9	8
30-May-96	156		155		1	5	9	7
31-May-96	216		216			10	9	3
01-Jun-96	249		249			3	14	3
02-Jun-96	261		261			3	9	1
03-Jun-96	219		219			4	9	2
04-Jun-96	268		268			4	16	
05-Jun-96	168		168			8	12	4
06-Jun-96	88	1	87			3	5	
07-Jun-96	160		159		1	3	10	
08-Jun-96	74		74			1	4	
09-Jun-96	45		45			1	3	
10-Jun-96	12		12				3	
11-Jun-96	21		21				2	
12-Jun-96	31	1	30				2	
13-Jun-96	1				1			
Totals	14178	286	13828	27	37	337	493	100

Table 3.3 Coho Length Data

Date	N	Mean	St Dev	Min	Max
28-Apr-96	100	135	10.5	114	181
29-Apr-96	99	138	10.9	112	175
30-Apr-96	100	138	12.1	111	172
01-May-96	100	140	13.2	110	185
02-May-96	100	136	13.6	104	174
03-May-96	40	145	14.5	114	185
04-May-96	58	141	11.0	113	170
05-May-96	85	142	12.7	116	178
06-May-96	34	139	12.4	108	160
07-May-96	100	137	11.4	111	168
08-May-96	100	140	12.6	115	174
09-May-96	100	142	12.5	91	165
10-May-96	100	138	9.8	114	172
11-May-96	100	139	13.1	109	178
12-May-96	100	141	11.9	111	178
13-May-96	100	137	12.2	109	158
14-May-96	100	136	11.4	105	160
15-May-96	58	127	13.0	95	158
16-May-96	100	126	12.7	99	155
17-May-96	100	125	13.1	97	161
18-May-96	100	126	14.5	95	156
19-May-96	100	125	14.2	99	175
20-May-96	100	128	15.8	95	178
21-May-96	83	123	15.5	100	167
22-May-96	100	127	14.4	103	164
23-May-96	100	121	12.1	100	156
24-May-96	100	115	12.3	98	168
25-May-96	90	117	12.0	94	159
26-May-96	100	117	15.9	90	165
27-May-96	100	120	14.7	93	166
28-May-96	100	114	11.3	99	155
29-May-96	100	116	12.5	92	156
30-May-96	100	114	11.4	91	161
31-May-96	100	114	9.5	100	164
01-Jun-96	100	113	7.1	98	150
02-Jun-96	100	115	7.6	95	144
03-Jun-96	100	114	8.1	95	160
04-Jun-96	100	115	7.5	94	151
05-Jun-96	100	114	5.4	94	128
06-Jun-96	87	114	5.7	93	127
07-Jun-96	100	115	6.5	94	129
08-Jun-96	74	116	5.5	100	125
09-Jun-96	45	117	7.4	99	135
10-Jun-96	12	118	4.6	111	125
11-Jun-96	21	117	7.0	102	133
12-Jun-96	30	118	5.7	104	136
Totals	4016	126	15.8	90	185

Table 3.4 Age Data.

Length Range	Proportion of Age 1.0	Proportion of Age 2.0	Number of lengths	Number of Age 1.0	Number of Age 2.0	
	A	B	C	A*C	B*C	
90-94	1.00	0.00	13	13	0	
95-99	1.00	0.00	38	38	0	
100-104	1.00	0.00	143	143	0	
105-109	1.00	0.00	304	304	0	
110-114	1.00	0.00	525	525	0	
115-119	1.00	0.00	608	608	0	
120-124	1.00	0.00	362	362	0	
125-129	1.00	0.00	184	184	0	
130-134	1.00	0.00	168	168	0	
135-139	1.00	0.00	134	134	0	
140-144	0.93	0.07	162	150	12	
145-149	1.00	0.00	105	105	0	
150-154	0.89	0.11	79	70	9	
155-159	1.00	0.00	48	48	0	
160-164	1.00	0.00	15	15	0	
165-169	1.00	0.00	5	5	0	
170-174	1.00	0.00	3	3	0	
175-179	1.00	0.00	4	4	0	
				2879	21	Total
				0.993	0.007	Proportion

Table 3.5 Biological Data for Aged Coho Smolts

Age	Fork Length		
	N	Mean	SD
1.0	264	131	17.5
2.0	4	152	23.8

Table 3.6 CWT Tag Retention

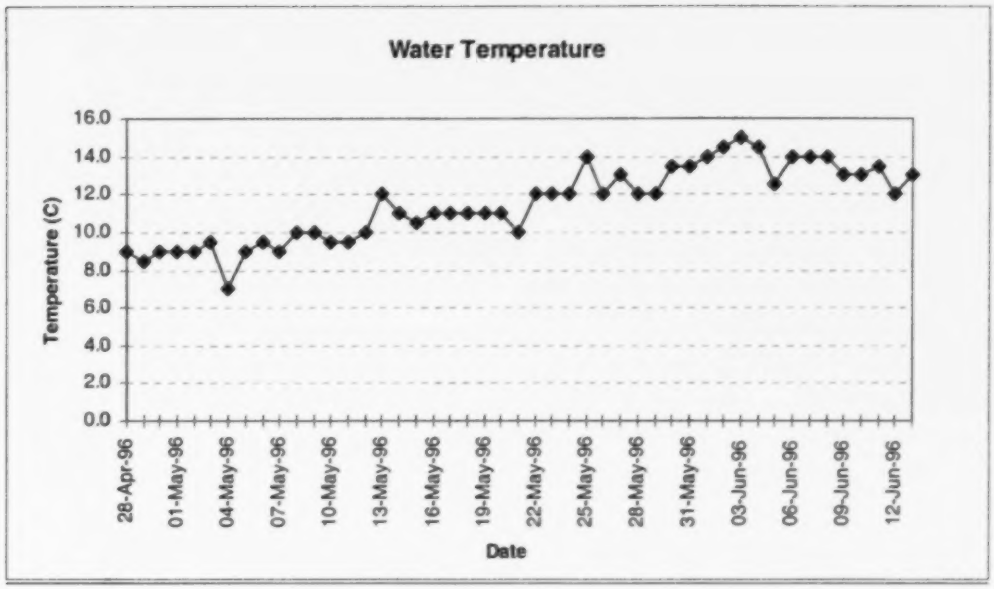
Date	N	# of Tags Retained	
09-May-96	100	100	
22-May-96	100	98	
05-Jun-96	100	100	
	300	298	Total
		0.993	Proportion

Table 3.7 CWT Release

Code	Total CWT'd	CWT'd morts	# tags at risk	Total Released
080813	9756	27	9729	9664
080814	4072	0	4072	4045

Table 3.8 Daily CWT Sequential Numbers

Date	CWT code	Sequential Start	Sequential End
28-Apr-96	080813	379	1040
29-Apr-96	080813	1041	2047
30-Apr-96	080813	2048	2447
01-May-96	080813	2448	2806
02-May-96	080813	2807	3010
03-May-96	080813	3011	3078
04-May-96	080813	3079	3162
05-May-96	080813	3163	3279
06-May-96	080813	3280	3330
07-May-96	080813	3331	4998
08-May-96	080813	4999	6181
09-May-96	080813	6182	6468
10-May-96	080813	6469	7757
11-May-96	080813	7758	8571
12-May-96	080813	8572	9510
13-May-96	080813	9511	11711
14-May-96	080813	11712	11911
15-May-96	080813	11912	11995
16-May-96	080813	11996	12184
17-May-96	080813	12185	12775
18-May-96	080813	12776	13045
19-May-96	080813	13046	13352
20-May-96	080813	13353	13686
21-May-96	080814	162	260
22-May-96	080814	261	777
23-May-96	080814	778	1198
24-May-96	080814	1199	1721
25-May-96	080814	1722	1848
26-May-96	080814	1849	2167
27-May-96	080814	2168	2537
28-May-96	080814	2538	2797
29-May-96	080814	2798	3062
30-May-96	080814	3063	3264
31-May-96	080814	3265	3544
01-Jun-96	080814	3545	3858
02-Jun-96	080814	3859	4187
03-Jun-96	080814	4188	4464
04-Jun-96	080814	4465	4805
05-Jun-96	080814	4806	5019
06-Jun-96	080814	5020	5166
07-Jun-96	080814	5167	5351
08-Jun-96	080814	5352	5288
09-Jun-96	080814	5289	5533
10-Jun-96	080814	5534	5551
11-Jun-96	080814	5552	5596
12-Jun-96	080814	5597	5637



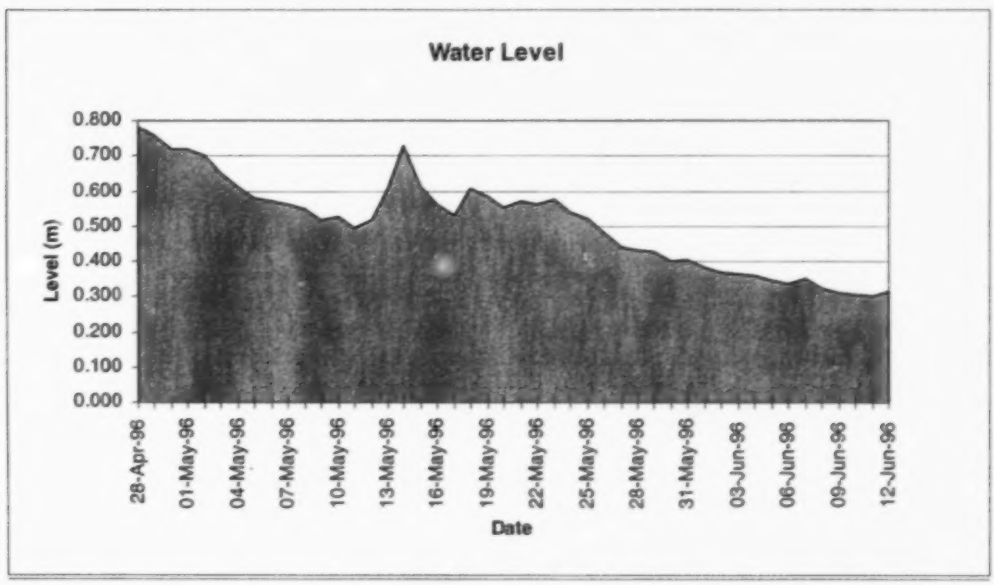


Figure 3.1 Water Observations

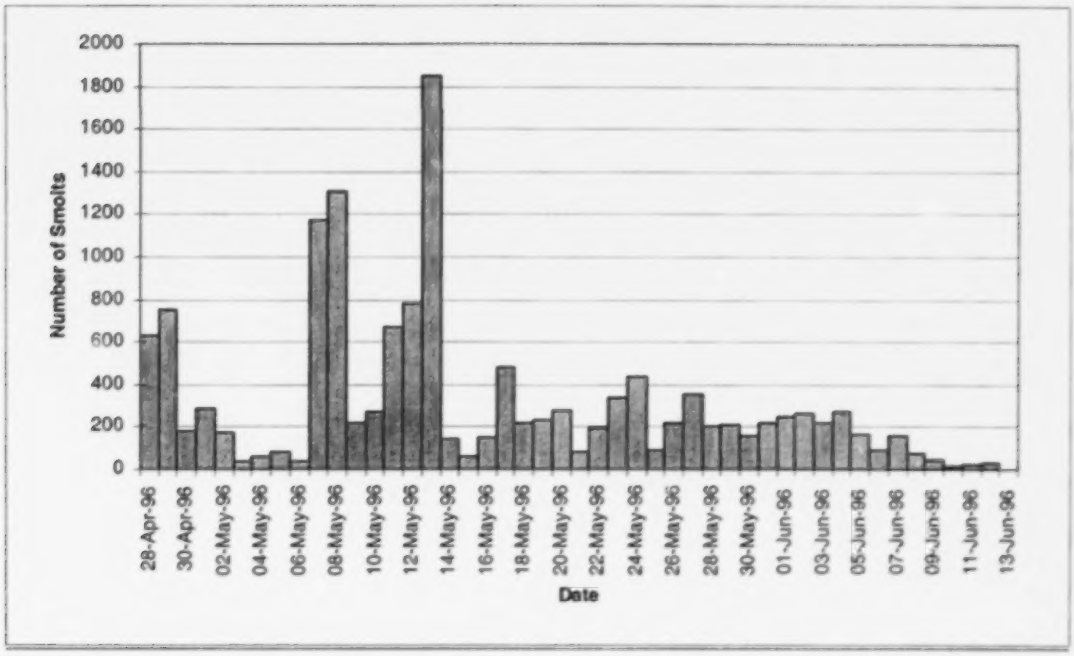


Figure 3.2 Downstream Coho Smolt Migration

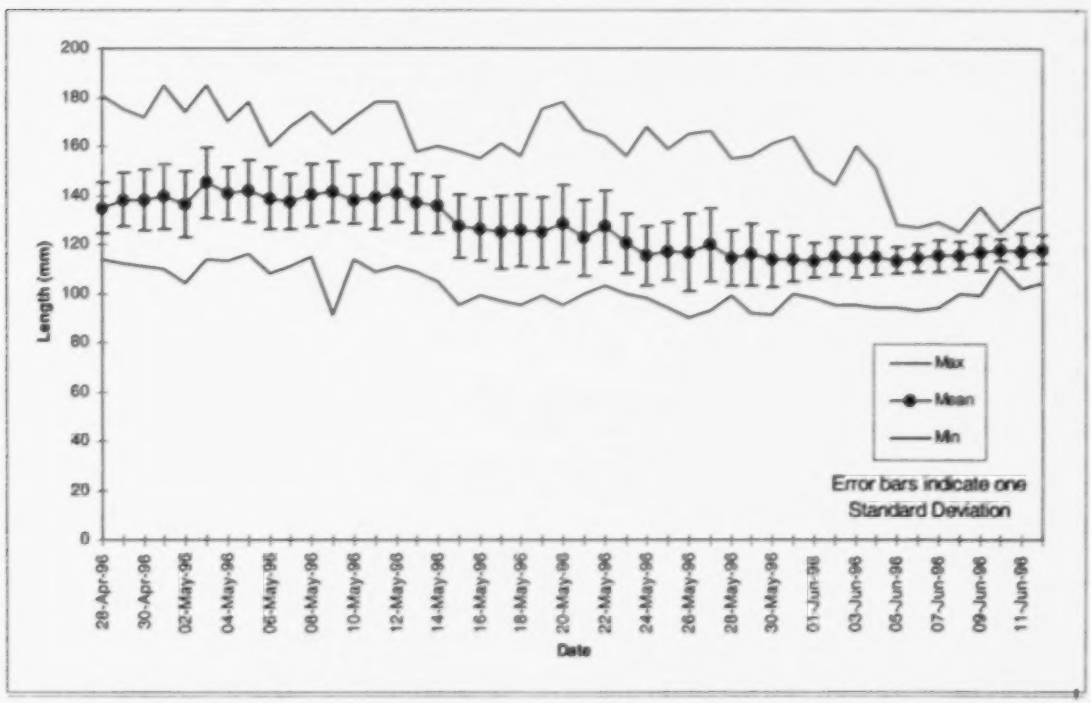


Figure 3.3 Mean Fork Length of Coho Smolts

Black Creek Fall 1996 Operations

Tables and Figures

Table 4.1 Water Observations

Date	Water Temperature (°C)	Water Level (m)
18-Oct-96	7.5	0.800
19-Oct-96	6.5	0.730
20-Oct-96	6.0	0.650
21-Oct-96	7.0	0.615
22-Oct-96	7.0	0.840
23-Oct-96	6.5	0.755
24-Oct-96	6.5	0.930
25-Oct-96	6.5	0.850
26-Oct-96	5.0	0.760
27-Oct-96	6.5	0.705
28-Oct-96	7.5	0.890
29-Oct-96	7.0	0.875
30-Oct-96	5.0	0.810
31-Oct-96	4.0	0.715
01-Nov-96	4.5	0.660
02-Nov-96	5.5	0.615
03-Nov-96	5.0	0.585
04-Nov-96	4.0	0.680
05-Nov-96	4.5	0.650
06-Nov-96	4.5	0.610
07-Nov-96	3.5	0.575
08-Nov-96	4.5	1.280
09-Nov-96	5.5	1.070
10-Nov-96	6.0	0.950
11-Nov-96	6.5	0.835
12-Nov-96	7.5	0.800
13-Nov-96	7.0	0.825
14-Nov-96	7.5	0.760
15-Nov-96	5.0	0.710
16-Nov-96	4.5	0.710
17-Nov-96	3.0	0.690
18-Nov-96	2.0	0.665
19-Nov-96	1.5	0.635
20-Nov-96	0.5	0.600
21-Nov-96	1.0	0.570
22-Nov-96	0.0	0.550
23-Nov-96	-0.5	0.530
24-Nov-96	0.0	0.530
25-Nov-96	1.0	0.690
26-Nov-96	1.5	0.855
27-Nov-96	3.5	1.040
28-Nov-96	3.0	1.000
29-Nov-96	2.0	0.910
30-Nov-96	4.0	1.060

Table 4.2 Daily Counts of Coho Adults by Sex, and Other Species

Date	Coho			CTT
	Females	Males	Jacks	unclipped
18-Oct-96	0	2	30	5
19-Oct-96	2	2	21	1
20-Oct-96	0	0	0	0
21-Oct-96	0	0	1	0
22-Oct-96	14	25	46	9
23-Oct-96	0	0	5	2
24-Oct-96	0	1	0	1
25-Oct-96	0	1	27	3
26-Oct-96	0	0	0	0
27-Oct-96	0	0	1	0
28-Oct-96	3	12	1	2
29-Oct-96	18	14	81	11
30-Oct-96	0	0	1	0
31-Oct-96	0	0	0	0
01-Nov-96	0	0	0	0
02-Nov-96	0	0	0	0
03-Nov-96	0	0	0	0
04-Nov-96	0	0	0	0
05-Nov-96	0	0	0	0
06-Nov-96	0	0	0	0
07-Nov-96	0	0	0	0
08-Nov-96	0	0	2	0
09-Nov-96	0	0	0	0
10-Nov-96	19	16	50	12
11-Nov-96	3	2	25	16
12-Nov-96	2	3	10	15
13-Nov-96	4	3	22	6
14-Nov-96	0	1	6	1
Total	65	82	329	84
# of fin clips	43	51	53	4
% clipped	66.2	62.2	16.1	4.8

In addition, 1 RBT (10-Nov-96), 1 female (10-Nov-96) and 1 male (13-Nov-96) chum salmon (*O. keta*) were enumerated.

Table 4.3 POH Length Frequency of Coho Adults, by Sex

Length Range	Female	Male	Jack
191 - 200	0	0	1
201 - 210	0	0	3
211 - 220	0	0	6
221 - 230	0	0	16
231 - 240	0	0	23
241 - 250	0	1	36
251 - 260	0	0	42
261 - 270	0	1	39
271 - 280	0	0	38
281 - 290	0	0	21
291 - 300	0	0	23
301 - 310	0	2	12
311 - 320	0	3	7
321 - 330	0	2	1
331 - 340	0	0	2
341 - 350	0	0	1
351 - 360	0	4	0
361 - 370	0	2	1
371 - 380	0	5	0
381 - 390	0	2	0
391 - 400	1	2	0
401 - 410	0	3	0
411 - 420	0	6	0
421 - 430	1	3	0
431 - 440	1	3	0
441 - 450	3	2	0
451 - 460	2	2	0
461 - 470	3	1	0
471 - 480	4	3	0
481 - 490	4	4	0
491 - 500	3	3	0
501 - 510	4	0	0
511 - 520	1	3	0
521 - 530	7	3	0
531 - 540	1	1	0
541 - 550	2	0	0
551 - 560	0	0	0
561 - 570	3	2	0
571 - 580	3	0	0
581 - 590	1	1	0
591 - 600	1	0	0
601 - 610	0	0	0
611 - 620	0	0	0
621 - 630	0	0	0
631 - 640	0	0	0
641 - 650	0	0	0
651 - 660	0	0	0
661 - 670	0	0	0
671 - 680	0	0	0
681 - 690	0	0	0
691 - 700	0	0	0
Totals	45	64	272

Table 4.4 Biological Data

POH Length	Female	Male	Jack
Count	45	64	272
Average	504	424	265
StdDev	47.4	75.7	26.5
Max	600	582	368
Min	394	247	200

Fork Length	Female	Male	Jack
Count	45	61	123
Average	620	541	332
StdDev	56.0	98.0	34.2
Max	720	748	410
Min	485	311	250

Weight	Female	Male	Jack
Count	46	61	115
Average	3.02	2.02	0.51
StdDev	0.89	1.13	0.153
Max	5.05	5.3	0.95
Min	0.55	0.45	0.20

Table 4.5 Age Data (corrected designations)

Age	Jack	Male	Female
1.0	38		
1.1		30	22
2.0	2		
2.1		3	3
?.0[1]	31		
?.1[1]		29	25

[1] - unknown freshwater age

Table 4.6 CWT Results

Date	Site Collected	code	seq #	comment
23-Oct-96	fence sample	080813	2594	Jack Sample
29-Oct-96	fence sample	080813	10963	Jack Sample
10-Nov-96	fence sample	080813	2841	Jack Sample
10-Nov-96	fence sample	080813	10551	Jack Sample
14-Nov-96	fence sample	080813	1509	Jack Sample
29-Nov-96	fence	080813	605	jack
29-Nov-96	fence	080813	3823	jack, no punch, no tag
20-Nov-96	fence	080812	1052	female

Table 4.7 Summary of CWT Recoveries

CWT Code	Type[1]	Observed CWT			Estimated CWT			Tags released	Proportion Survival		
		Female	Male	Jack	Female	Male	Jack		Female	Male	Jack
080811	sm							2700			
080810	lg1							9344			
080812	lg2	1			43			6164	0.0070		
080813	1			7			55	9664			0.0057
080814	2							4045			

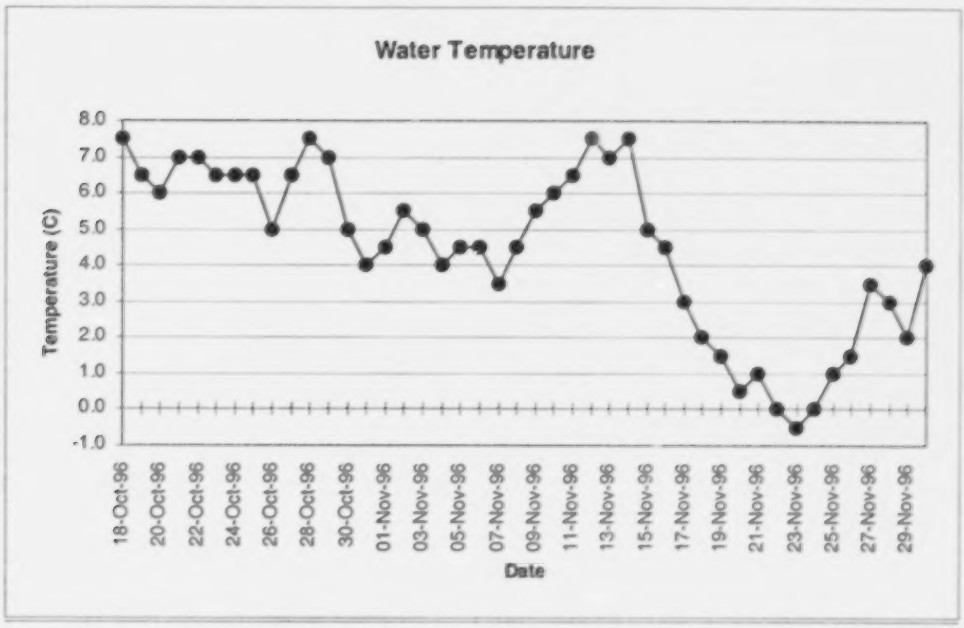
[1] - sm refers to smolts < 120 mm, lg refers to smolts ≥120 mm. The number refers to the chronological order in which the tag codes were used (i.e. 1 = earliest). In 1996, the smolts were not divided into larges and smalls.

Table 4.8 Summary of Carcass Surveys

Date	Sex	Clip	Location
11/15/96	J'		C-2
11/20/96	F	Y	C-5
11/20/96	J		C-5
11/20/96	F		D-2
11/26/96	J		Fence
11/27/96	J		Fence
11/27/96	J		Fence
11/27/96	J		Fence
11/28/96	J		Fence
11/29/96	J	Y	Fence
11/29/96	J		Fence
11/29/96	J	Y	Fence
11/30/96	J		Fence
11/30/96	J		Fence

Table 4.9 Estimated return of coded-wire tag coho in 1996.

Tagged Release (1994)		18,152
Escapement		182
Catch Region:		
FWSP	FWSP	-
Net	CN	-
	FGN	-
	GSN	-
	JFN	-
	JSN	9
	NN	11
	SWVN	-
Sport	ACSPT	-
	CSPT	42
	GSPTN	77
	GSPTS	-
	JFSPT	37
	WSPT	-
Troll	GSTR	-
	NCTR	-
	NTR	25
	NWTR	92
	SCTR	-
	SWTR	72
US	AK	70
	US South	6
	Total Return	611
	Total Catch	429
	Survival	3.4
	Exploitation Rate	70.2
	Marine Exploitation Rate	70.2
	% Inside	18.1



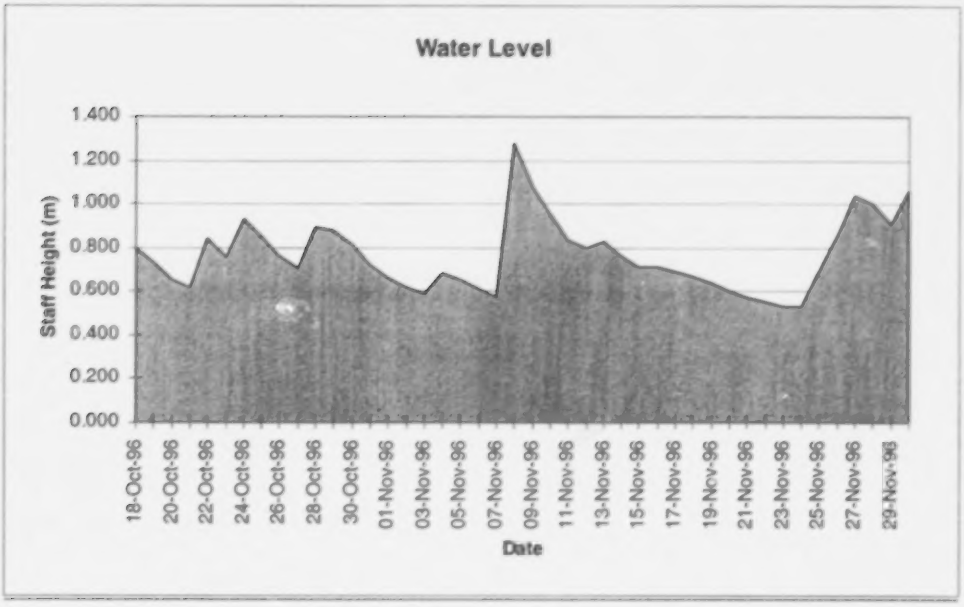


Figure 4.1 Water Observations

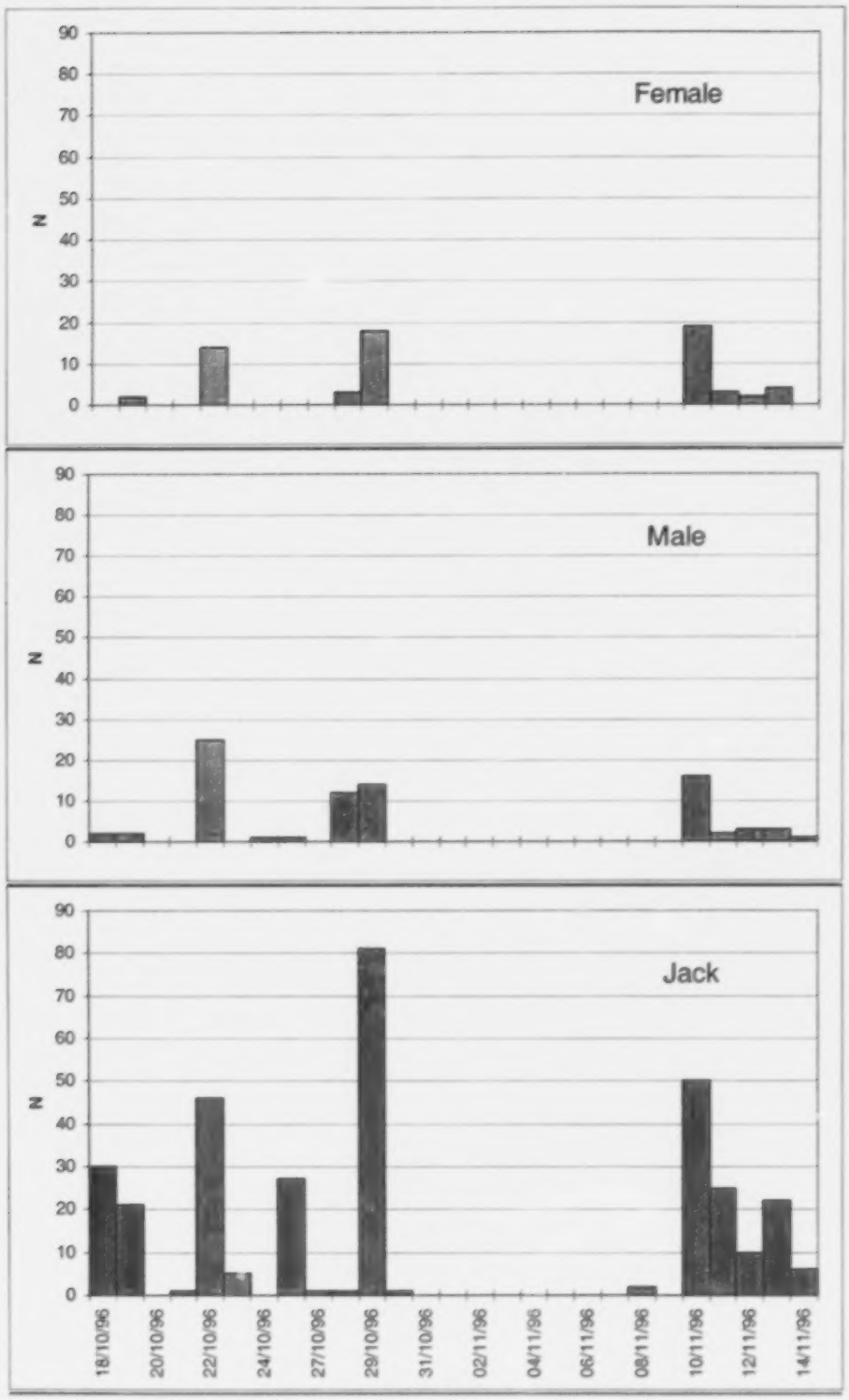


Figure 4.2 Daily Counts of Coho Adults, by Sex

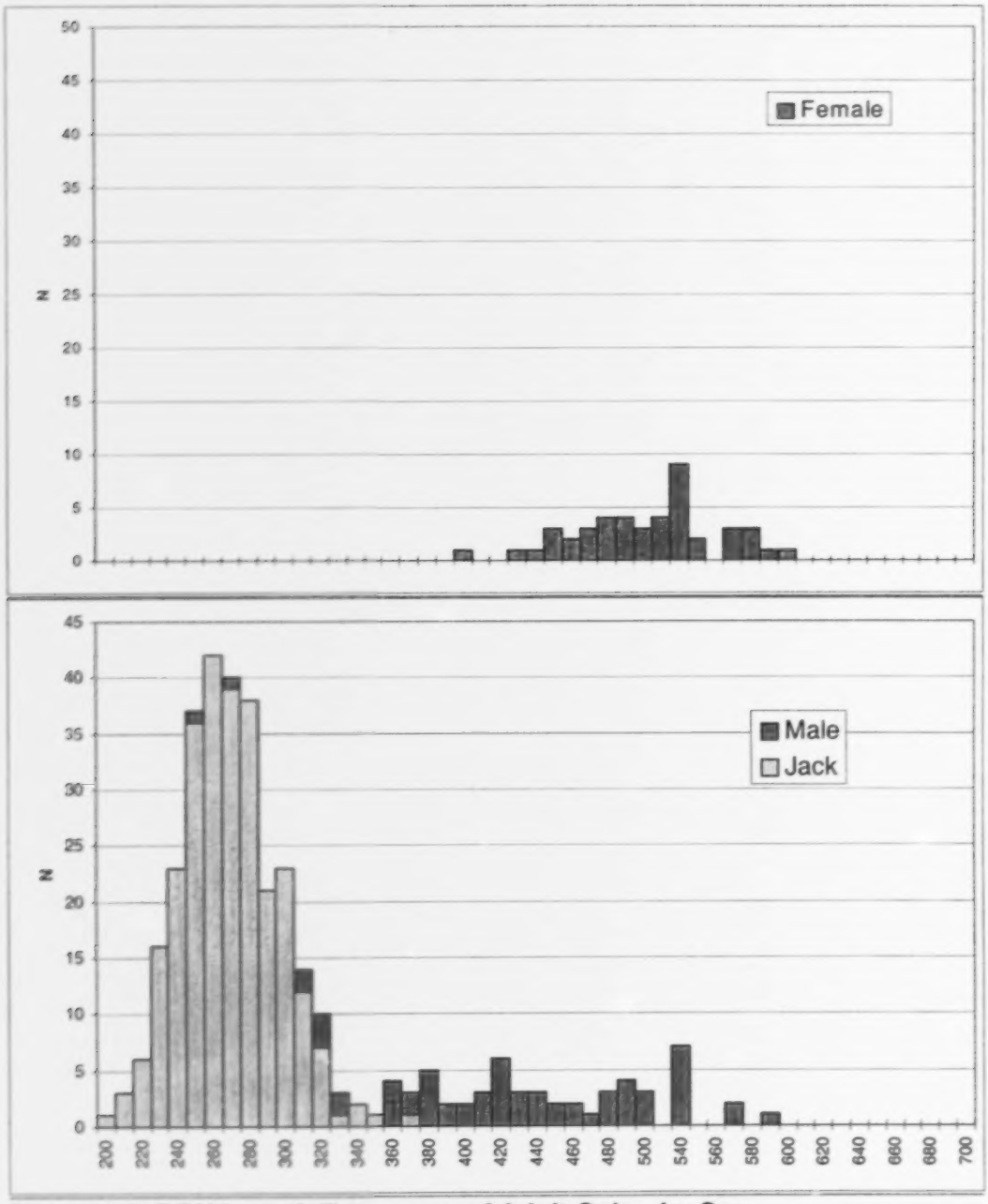


Figure 4.3 POH Length Frequency of Adult Coho, by Sex